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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04N 5/76 — A1

(11) International Publication Number: **WO 95/26103**

(43) International Publication Date: 28 September 1995 (28.09.95)

(21) International Application Number: PCT/US95/03435

(22) International Filing Date: 17 March 1995 (17.03.95)

(30) Priority Data:
08/214,859 18 March 1994 (18.03.94) US

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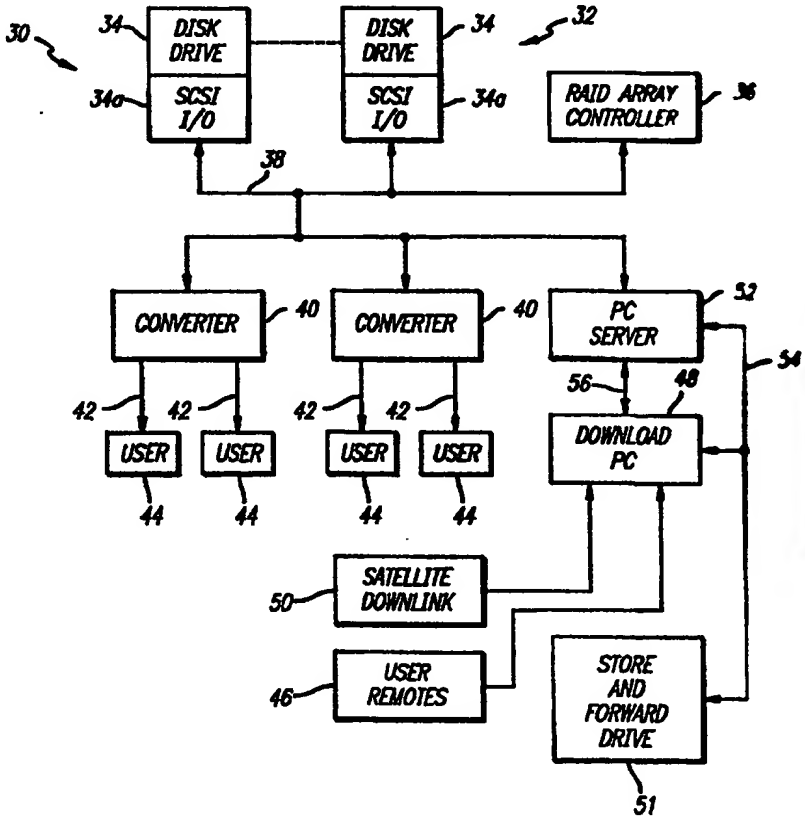
(81) Designated States: AU, CA, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
With amended claims.

(54) Title: ON-DEMAND VIDEO SERVER SYSTEM

(57) Abstract

A plurality of movies are distributively stored in digital form on a mass storage unit such as a Redundant Array of Inexpensive Drives (RAID) disk drive system (32). A master controller (36) receives movie requests from users, and generates designation commands through a Small Computer System Interface (SCSI) bus (38) that designates a retrieval controller (40) at the requesting user's facility, and locations of the requested movie data in the RAID system (32). Successive designation commands are generated for successive blocks of the movie data. A designated retrieval controller (40) reads a designated block of data from the RAID system (32) through the SCSI bus (38), and converts the retrieved data into video picture and audio format at the requesting user's facility. The movie data is preferably compressed on the RAID system (32) in Motion Picture Experts Group (MPEG) format, and decompressed by the retrieval controllers (40).



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ON-DEMAND VIDEO SERVER SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to the art of multi-user, on-demand video entertainment systems, and more specifically to a video server system including independent, concurrently operating remote data retrieval controllers for accessing video files from a central storage.

Description of the Related Art

User-on-demand, also known as pay-per-view, video entertainment systems are becoming increasingly popular in motel and hotel facilities as well as in larger scale community cable television (CATV) systems.

Such a system includes a video server located at a central location that stores a plurality of movies that can be selected for viewing by one or more users at any desired time. The video server is connected to television receivers at the individual user locations by a cable or other network.

Each user is provided with means for requesting that a selected movie be retrieved from the server and shown on his television receiver. In a small scale system such as

installed in a motel or hotel, an interactive remote control unit can be provided for each television receiver by which the user can request a movie using a menu system displayed on the television screen. In a large scale system such as a community cable television network, the user can call the cable company by telephone to request that the movie fed to his home receiver.

A prior art video server system 10 is illustrated in FIG. 1, and comprises a mass storage unit in the form of a Redundant Array of Inexpensive Drives (RAID) disk drive array 12. Data access to and from the individual drives of the RAID array 12 is controlled by a master controller 14.

A plurality of movies are stored on the array 12 in a distributed or "striped" manner such that any movie can be viewed by more than one user, or even by all users simultaneously starting at different times. The RAID arrangement is further advantageous in that it balances the usage load over the disk drives.

The basic RAID configuration, including a description of distributed storage of data, is disclosed in U.S. Patent No. 4,870,643, entitled "PARALLEL DRIVE ARRAY STORAGE SYSTEM", issued Sept. 26, 1989 to David Bultman et al, and an improved arrangement is disclosed in my prior U.S. Patent No. 5,191,584, entitled "MASS STORAGE ARRAY WITH EFFICIENT PARITY CALCULATION", issued March 2, 1993. Both of these patents are assigned to the Micropolis Corporation of Chatsworth, CA, the assignee of the present invention.

In the illustrated prior art configuration, all of the video and audio movie data and control functions are processed by a PC server 16, which is typically a conventional personal computer (PC). A television receiver at the location of each user 18 is provided with an interactive remote control unit 20 by which the user can request a particular movie from a displayed menu on a pay-per-view basis. Movie requests from the remote control

units 20 are sent to the PC server 16.

In response to a movie request, the server 16 sends a command to the RAID array 12 to retrieve the data corresponding to the requested movie from the disk drives. The data is read out of the array 12 and fed back through the server 16 to a decoder array 36 which converts the data into an audio/visual channel and feeds it to the requesting user 18. In order to enable more than one user to view a movie simultaneously, data is retrieved from the array 12 in small time multiplexed blocks.

The prior art system of FIG. 1 is adequate for applications including only a few users. However, a data rate of approximately 375 kilobytes/second per user is required to provide substantially real-time viewing. The data throughput rate scales in proportion to the number of users. A typical personal class computer is capable of a data rate of approximately 6 megabytes. Thus, the system 10 as illustrated in FIG. 1 is only capable of serving approximately 16 users 18.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a multi-user, on-demand video server system in which the data throughput rate is not limited by a low speed processing device such as a personal computer as it is in a comparable system of the prior art. The present system is therefore capable of very high data rate operation using a Small Computer System Interface (SCSI) bus, enabling three or more times more users to be serviced by the system.

In a video server system according to the present invention, a plurality of movies are distributively stored in digital form on a mass storage unit such as a Redundant Array of Inexpensive Drives (RAID) disk drive system such that they can be viewed on demand by multiple users.

A master controller receives movie requests from

users, and generates designation commands through a SCSI data bus that designates a retrieval controller at the requesting user's facility, and locations of the requested movie data in the RAID system. Successive designation commands are generated for successive blocks of the movie data.

A designated retrieval controller reads a designated block of data from the RAID system through the SCSI bus, and converts the retrieved data into video picture and audio format to show the movie on a television receiver at the requesting user's facility.

The movie data is preferably compressed on the RAID system in Motion Picture Experts Group (MPEG) format, and decompressed by the retrieval controllers.

The above and other objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed description taken with the accompanying drawings, in which like reference numerals refer to like parts.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a prior art on-demand, multi-user video server system;

FIG. 2 is a block diagram illustrating a video on-demand, multi-user video server system embodying the present invention;

FIGs. 3a and 3b are flowcharts illustrating the operation of the video server system of FIG. 2;

FIG. 4 is a block diagram illustrating a data retrieval controller of the present system; and

FIG. 5 is a block diagram illustrating a controller module of the controller of FIG. 4.

DETAILED DESCRIPTION OF THE INVENTION

A multi-user, on-demand video/audio server system 30

according to the present invention is illustrated in FIG. 2. The system 30 comprises a mass storage which is preferably constituted by a Redundant Array of Inexpensive Drives (RAID) array 32, including individual disk drives 34 that are controlled synchronously by a master RAID controller 36. Each disk drive 34 includes a Small Computer System Interface (SCSI) input-output (I/O) interface 34a for connection of the respective disk drive 34 to a wide (16 bit) SCSI data bus 38 that supports a data rate of approximately 18 to 19 megabytes/second.

The system 30 further comprises a plurality of data retrieval controller units or converters 40 that are also connected to the data bus 38. Each converter 40 has at least one output that is connected through a video/audio channel 42 to a television receiver of a user 44. The user receivers can be provided in individual rooms of a motel or hotel facility, or in the homes of individual customers.

A plurality of movies are distributively stored on the RAID array 32 such that any movie can be retrieved and viewed by any user 44 at any time. This is made possible by the manner in which the movie data is stored on the array 32.

More specifically, data elements or bytes of movie video and audio data are stored across the drives 34 of the array 32 in a "striped" arrangement. Each stripe comprises a plurality of successive data bytes that are stored in the same numerical location in the drives 34 respectively. One of the drives 34 is preferably used to store a parity byte for each stripe such that the data for a drive that has malfunctioned or is temporarily removed from service can be reconstructed to provide interrupted operation. The distributed data storage arrangement using a RAID array is described in more detail in the above referenced U.S. patents.

Each user 44 is provided with an interactive remote

control unit for requesting a movie from a menu displayed on the user's television receiver. The remote control units are collectively designated as 46, and cause signals or commands designating requested movies to be sent to a download PC 48 which is typically embodied by a personal computer.

The download PC 48, in addition to processing movie requests from the users 44, is used to convert movies received via a downlink 50 from a source provider in analog form into compressed video and audio digital form. The preferred compression format is Motion Picture Experts Group (MPEG), although other compression formats can be used.

The downloaded movie data is temporarily stored on a store and forward drive 51 prior to and during compression. The download PC 48 feeds the compressed video and audio digital to a PC server 52 via a narrow (8 bit) SCSI data bus 54, which in turn stores the data on the drives 34 of the RAID array 32 in the manner described above.

The method of the present invention by which movie data is retrieved from the RAID array 32 and supplied to the requesting users 44 is generally illustrated in the flowchart of FIGs. 3a and 3b. The PC server 52, which can also be a PC class computer, receives requests for movies from the download PC 48 via a low speed data bus 56 such as an RS-232 bus. A movie request as generated by the download PC 48 typically consists of an identification name or number of the user 44 that requested the movie and the name or identification number of the movie.

The PC server 52 stores information designating the specific locations in the array 32 in which each movie is stored. In response to a movie request, the PC server generates a list of all of the locations for the requested movie, and sends a SCSI designation command through the SCSI data bus 38 that designates the converter 40 that is

connected to supply the requesting user 44, and a designation of locations in the array 32 from which the designated converter 40 is to retrieve data.

More specifically, the PC server 52 sends successive designation commands to the selected converter 40 designating the locations of successive blocks of data for the requested movie in the array 32. Typically, each designation command will contain the locations of data corresponding to 2 seconds of viewing time for the movie. Assuming a data rate of 375 megabytes/second, a 2 second block of data will correspond to 750 megabytes of data stored in the array 32.

In response to a designation command from the PC server 52, the selected converter 40 responds by sending a SCSI read command through the bus 38 that causes the data at the designated locations in the array 32 to be read out or retrieved and transmitted over the bus 38 to the converter 40.

As will be described in detail below, each converter 40 includes a data buffer that can accommodate asynchronous transmission of data to and from the converter 40 at different rates. The converter 40 decodes or decompresses the MPEG encoded digital data to produce analog picture and sound data and sends it to the requesting user 44 via the channel 42. In this manner, 2 seconds of the requested movie are retrieved from the RAID array 32 and shown on the requesting user's television receiver.

As the decompression and display of the 2 second block of data approaches completion, the converter 40 sends a message to the PC server 52 through the bus 38 indicating that execution of the command has been successfully completed. If the block of data that was just displayed was the last block of the movie, the operation is terminated. If more blocks of the movie remain, the PC server 52 sends a designation command to the converter 40

to retrieve and show the next 2 second block of the movie.

The converters 40 are preferably identical, with one converter 40 being illustrated in FIG. 4. Although the invention is not limited to any specific configuration, the converter 40 preferably comprises a SCSI converter unit 60 that is commercially available as a TEC 356 TRIPLE EMBEDDED CONTROLLER from Emulex Micro Devices of Costa Mesa, CA. The converter unit 60 is connected to a microprocessor 62 and a ROM/RAM memory 64 via a microprocessor bus 66. The converter unit 60 is also connected to a Dynamic Random Access Memory (DRAM) buffer memory 68 via a memory bus 70. The converter 60 is also connected to the wide SCSI bus 38.

The SCSI converter 60 is illustrated in more detail in FIG. 5 as comprising a microprocessor logic 72 that is connected to the microprocessor bus 66 and to a buffer controller 74. A SCSI processor 76 is connected between the buffer controller 74 and the wide SCSI bus 38. The buffer controller 74 is connected to the buffer memory 68 through the memory bus 70.

The converter 60 further comprises a disk formatter 78 having a disk port 80 which is not used in the preferred embodiment of the invention since the drives 34 of the RAID array 32 are provided with the SCSI I/O units 34a. However, the scope of the invention is not so limited. If disk drives that are not provided with a SCSI capability are used, for example, they can be connected to the converter 60 via the disk port 78.

The microprocessor 62 is typically an Intel 80186, although the invention is not so limited. The microprocessor 62 controls the data retrieval and forwarding operations as directed by an operating program stored in the memory 64. In response to a designation command applied to the converter 60 through the bus 38, the microprocessor 62 sends a SCSI read command to the RAID array 32 instructing that the selected data for the 2

second movie block be retrieved and sent back through the bus 38 in SCSI format.

The microprocessor 62 controls the controller 60 to cause the digital movie data that is addressed thereto by the array 32 to be converted from SCSI format into a format suitable for storage in the memory 68. The memory bus 70 comprises two Direct Memory Access (DMA) channels that enable data to be simultaneously written into and read out of the memory 68.

The 2 second block of data is read out of the buffer memory 68 under control of the microprocessor 62 and fed to a system decoder 72 for the requesting user 44 through the microprocessor bus 66. A single converter 40 can support more than one, here illustrated as two, video/audio channels 42 for respective users 44, with a separate decoder 72 provided for each user 44.

The system decoder 72 separates the video digital data from the audio digital data and feeds them to a video decoder 74 and an audio decoder 76 respectively along with requisite timing signals. Each channel 42 is constituted by analog audio and video outputs of the decoders 74 and 76 respectively.

The video decoder 74 is preferably embodied by a CL950 MPEG VIDEO DECODER that is available from C-Cube Microsystems of Milpitas, CA. The decoder 74 decompresses the digital video data to produce analog video picture data in, preferably, RS-170A Analog Composite Video format. The decoder 76 decompresses the digital audio data to produce an analog audio signal in, preferably, the 48 KHz Analog Video standard. These signals are transmitted through the channel 42 and applied to show the 2 second block of the movie on the requesting user's television receiver.

The two DMA channels of the memory bus 70 enable the converter 60 to compensate for variable data rates that are inherent in data retrieval from the RAID array 32 and

decompression of MPEG encoded data. Since a number of users 44 can be watching movies at the same time and the designation commands compete for transmission over the bus 38 under the SCSI protocol, data will be received by the converter 40 from the RAID array 32 and stored in the buffer memory 68 at a variable rate. This rate will be much higher than the rate at which data is read out of the buffer memory 68 and decompressed by the decoders 74 and 76.

The decoders 74 and 76 feed the analog output signals into the channel 42 at a fixed rate corresponding to a video frame rate of 30 frames/second. MPEG decompression is performed at a variable rate depending on the correlation between adjacent video frames. For this reason, data will be read out of the buffer memory 68 and applied to the decoder 72 at a variable rate. The buffer memory 68 is required to enable the data to be retrieved from the RAID array 32 and output to the decoder 72 at different rates.

When the buffer memory 68 is almost empty (less than a predetermined number of bytes remain in the memory 68), the microprocessor 62 sends a SCSI message to the PC server 52 indicating that the operation of decompressing and showing the selected 2 seconds of movie data has been completed. In response to this message, the PC server 52 sends a designation command to the converter 40 to cause data corresponding to the next 2 second block of the movie to be retrieved from the RAID array 32 and shown on the user's television receiver.

The present invention enables a number of converters to supply video and audio movie signals to respective users 44 simultaneously, with the data transfers over the SCSI bus 38 being arbitrated by the SCSI protocol. In an exemplary application, 14 converters 40 can be connected to the RAID array 32, with 4 users being served by each

converter 40 via a respective channel 42. Thus, a total of 56 users can be served by the system 30, as opposed to 16 users for the prior art system of FIG. 1.

Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope thereof.

For example, the SCSI bus architecture can be replaced with another type of interconnect protocol, for example Peripheral Component Interconnect (PCI) or optical fibers.

Another modification that is within the scope of the invention is to provide two RAID arrays, each of which has its own SCSI interface, and distribute the movie data across the two arrays. 56 users can be served by each SCSI interface for a total of 112, thereby doubling the number of users over the basic configuration described above. It is also possible to combine three or more RAID arrays in an essentially similar manner.

I CLAIM:

1. A data storage and retrieval system, comprising:

a storage for storing data;

a data bus connected to the storage;

a plurality of data retrieval controllers that are connected to the data bus and have data outputs; and

a master controller for generating and sending designation commands through the data bus, each designation command designating a selected retrieval controller and selected data to be retrieved from the storage by said selected retrieval controller;

each selected retrieval controller retrieving said selected data from the storage through the data bus and producing said selected data at said data output thereof in response to a respective designation command.

2. A system as in claim 1, in which:

the storage stores said data in the form of a digital data file; and

the master controller generates and sends successive designation commands to a selected retrieval controller designating successive blocks of said digital data file respectively.

3. A system as in claim 2, in which said digital data file comprises video movie data.

4. A system as in claim 2, in which the storage comprises a plurality of disk drives for distributively storing said blocks of said digital data file.

5. A system as in claim 1, in which:

the master controller generates and sends designation commands through the data bus to the retrieval

controllers using Small Computer System Interface (SCSI) protocol; and

the retrieval controllers retrieve data from the storage through the data bus using SCSI protocol.

6. A system as in claim 5, in which:

the retrieval controllers retrieve data from the storage by sending SCSI read commands through the data bus to the storage; and

the storage transmits data through the data bus to the retrieval controllers in SCSI format in response to the SCSI read commands.

7. A system as in claim 5, in which:

the storage stores said data in the form of digital video data;

the retrieval controllers convert retrieved digital video data from SCSI format into video picture format.

8. A system as in claim 1, in which:

the storage stores said data in the form of digital video data; and

each retrieval controller comprises:

a buffer for storing retrieved digital video data;

a decoder for converting retrieved digital video data into video picture data; and

a processor for storing retrieved video data in the buffer at a first rate, and transferring retrieved video data from the buffer to the decoder at a second rate that is different from said first rate.

9. A system as in claim 1, in which:

the storage stores said data in the form of

compressed digital data; and

each retrieval controller comprises a decoder for decompressing said compressed digital data.

10. A system as in claim 1, in which:

the storage stores said data in the form of digital video data that is compressed in Motion Picture Experts Group (MPEG) format; and

each retrieval controller comprises an MPEG decoder for decompressing said digital video data.

11. A data storage and retrieval method, comprising the steps of:

(a) storing data in a storage;

(b) providing a plurality of data retrieval controllers that are connected to the storage and have data outputs; and

(c) sending designation commands to selected retrieval controllers causing them to retrieve selected data from the storage and produce said selected data at said data outputs thereof.

12. A method as in claim 11, in which:

step (a) comprises storing said data in the form of a digital data file; and

step (c) comprises generating and sending successive designation commands to a selected retrieval controller designating successive blocks of said digital data file respectively.

13. A method as in claim 12, in which step (a) comprises storing said digital data file as comprising video movie data.

14. A method as in claim 12, in which step (a)

comprises distributively storing said blocks of said digital data file on a plurality of disk drives.

15. A method as in claim 11, in which step (c) comprises generating and sending designation commands to the retrieval controllers through a data bus using Small Computer System Interface (SCSI) protocol, and causing the retrieval controllers to retrieve data from the storage through the data bus using SCSI protocol.

16. A method as in claim 15, in which step (c) comprises the substeps of:

(d) causing the retrieval controllers to retrieve data from the storage by sending SCSI read commands through the data bus to the storage; and

(e) causing the storage to transmit data through the data bus to the retrieval controllers in SCSI format in response to the SCSI read commands.

17. A method as in claim 15, in which:

step (a) comprises storing said data in the form of digital video data; and

step (c) further comprises converting retrieved digital video data from SCSI format into video picture format.

18. A method as in claim 11, in which:

step (a) comprises storing said data in the form of digital video data; and

step (c) comprises the substeps of:

(d) storing retrieved digital video data in a buffer;

(e) reading said retrieved digital video data out of the buffer at a different rate than said retrieved digital video data was stored in the buffer in

step (d); and

(f) converting said retrieved digital video data that was read out of the buffer in step (e) into video picture data.

19. A method as in claim 11, in which:

step (a) comprises storing said data in the form of compressed digital data; and

step (c) further comprises decompressing said compressed digital data.

20. A method as in claim 11, in which:

step (a) comprises storing said data in the form of digital video data that is compressed in Motion Picture Experts Group (MPEG) format; and

step (c) further comprises decompressing said digital video data.

21. A data retrieval controller for retrieving digital video data from a storage using Small Computer System Interface (SCSI) protocol, comprising:

a processor for receiving a SCSI designation command designating the controller and selected digital video data to be retrieved, and sending a SCSI command to the storage for reading said selected data; and

a decoder for converting said selected digital video data into video picture data after it has been read from the storage.

22. A controller as in claim 21, in which:

said digital video data is compressed in Motion Picture Experts Group (MPEG) format; and

the decoder comprises an MPEG decoder for decompressing said digital video data.

23. A controller as in claim 21, further comprising a buffer for temporarily storing said selected digital video data received from the storage at a first data rate and outputting said selected digital video data to the decoder at a second data rate that is different from the first data rate under control of the processor.

AMENDED CLAIMS

[received by the International Bureau on 01 August 1995 (01.08.95); original claims 1,11,21 amended; remaining claims unchanged (6 pages)]

1. (Amended) A data storage and retrieval system, comprising:

a storage for storing data;

a data bus connected to the storage;

a plurality of data retrieval controllers that are connected to the data bus and have data outputs; and

a master controller for generating and sending designation commands through the data bus, each designation command designating a selected retrieval controller and selected data to be retrieved from the storage by said selected retrieval controller;

each selected retrieval controller, in response to a respective designation command, retrieving said selected data from the storage through the data bus, producing said selected data at said data output thereof, and sending a message to the master controller through the bus indicating that execution of the designation command has been completed.

2. A system as in claim 1, in which:

the storage stores said data in the form of a digital data file; and

the master controller generates and sends successive designation commands to a selected retrieval controller designating successive blocks of said digital data file respectively.

3. A system as in claim 2, in which said digital data file comprises video movie data.

4. A system as in claim 2, in which the storage comprises a plurality of disk drives for distributively

storing said blocks of said digital data file.

5. A system as in claim 1, in which:

the master controller generates and sends designation commands through the data bus to the retrieval controllers using Small Computer System Interface (SCSI) protocol; and

the retrieval controllers retrieve data from the storage through the data bus using SCSI protocol.

6. A system as in claim 5, in which:

the retrieval controllers retrieve data from the storage by sending SCSI read commands through the data bus to the storage; and

the storage transmits data through the data bus to the retrieval controllers in SCSI format in response to the SCSI read commands.

7. A system as in claim 5, in which:

the storage stores said data in the form of digital video data;

the retrieval controllers convert retrieved digital video data from SCSI format into video picture format.

8. A system as in claim 1, in which:

the storage stores said data in the form of digital video data; and

each retrieval controller comprises:

a buffer for storing retrieved digital video data;

a decoder for converting retrieved digital video data into video picture data; and

a processor for storing retrieved video data in the buffer at a first rate, and transferring retrieved video data from the buffer to the decoder at a second rate that is different from said first rate.

9. A system as in claim 1, in which:
the storage stores said data in the form of compressed digital data; and
each retrieval controller comprises a decoder for decompressing said compressed digital data.

10. A system as in claim 1, in which:
the storage stores said data in the form of digital video data that is compressed in Motion Picture Experts Group (MPEG) format; and
each retrieval controller comprises an MPEG decoder for decompressing said digital video data.

11. (Amended) A data storage and retrieval method, comprising the steps of:
(a) storing data in a storage;
(b) providing a plurality of data retrieval controllers that are connected to the storage and have data outputs; and
(c) sending designation commands to selected retrieval controllers causing them to retrieve selected data from the storage, produce said selected data at said data outputs thereof, and send a message indicating that execution of the designation command has been completed.

12. A method as in claim 11, in which:
step (a) comprises storing said data in the form of a digital data file; and
step (c) comprises generating and sending successive designation commands to a selected retrieval controller designating successive blocks of said digital data file respectively.

13. A method as in claim 12, in which step (a) comprises storing said digital data file as comprising video movie data.

14. A method as in claim 12, in which step (a) comprises distributively storing said blocks of said digital data file on a plurality of disk drives.

15. A method as in claim 11, in which step (c) comprises generating and sending designation commands to the retrieval controllers through a data bus using Small Computer System Interface (SCSI) protocol, and causing the retrieval controllers to retrieve data from the storage through the data bus using SCSI protocol.

16. A method as in claim 15, in which step (c) comprises the substeps of:

(d) causing the retrieval controllers to retrieve data from the storage by sending SCSI read commands through the data bus to the storage; and

(e) causing the storage to transmit data through the data bus to the retrieval controllers in SCSI format in response to the SCSI read commands.

17. A method as in claim 15, in which:

step (a) comprises storing said data in the form of digital video data; and

step (c) further comprises converting retrieved digital video data from SCSI format into video picture format.

18. A method as in claim 11, in which:

step (a) comprises storing said data in the form of digital video data; and

step (c) comprises the substeps of:

(d) storing retrieved digital video data in a buffer;

(e) reading said retrieved digital video data out of the buffer at a different rate than said retrieved digital video data was stored in the buffer in step (d); and

(f) converting said retrieved digital video data that was read out of the buffer in step (e) into video picture data.

19. A method as in claim 11, in which:

step (a) comprises storing said data in the form of compressed digital data; and

step (c) further comprises decompressing said compressed digital data.

20. A method as in claim 11, in which:

step (a) comprises storing said data in the form of digital video data that is compressed in Motion Picture Experts Group (MPEG) format; and

step (c) further comprises decompressing said digital video data.

21. (Amended) A data retrieval controller for retrieving digital video data from a storage over a Small Computer System Interface (SCSI) bus using SCSI protocol, comprising:

a processor for receiving a SCSI designation command through the SCSI bus designating the controller and selected digital video data to be retrieved, and sending a SCSI command to the storage through the SCSI bus for reading said selected data;

a decoder for converting said selected digital video data into video picture data after it has been read from the storage through the SCSI bus; and

a message sender for sending a message through the SCSI bus indicating that execution of the designation command has been completed.

22. A controller as in claim 21, in which:

said digital video data is compressed in Motion Picture Experts Group (MPEG) format; and

the decoder comprises an MPEG decoder for

decompressing said digital video data.

23. A controller as in claim 21, further comprising a buffer for temporarily storing said selected digital video data received from the storage at a first data rate and outputting said selected digital video data to the decoder at a second data rate that is different from the first data rate under control of the processor.

FIG. 1 PRIOR ART

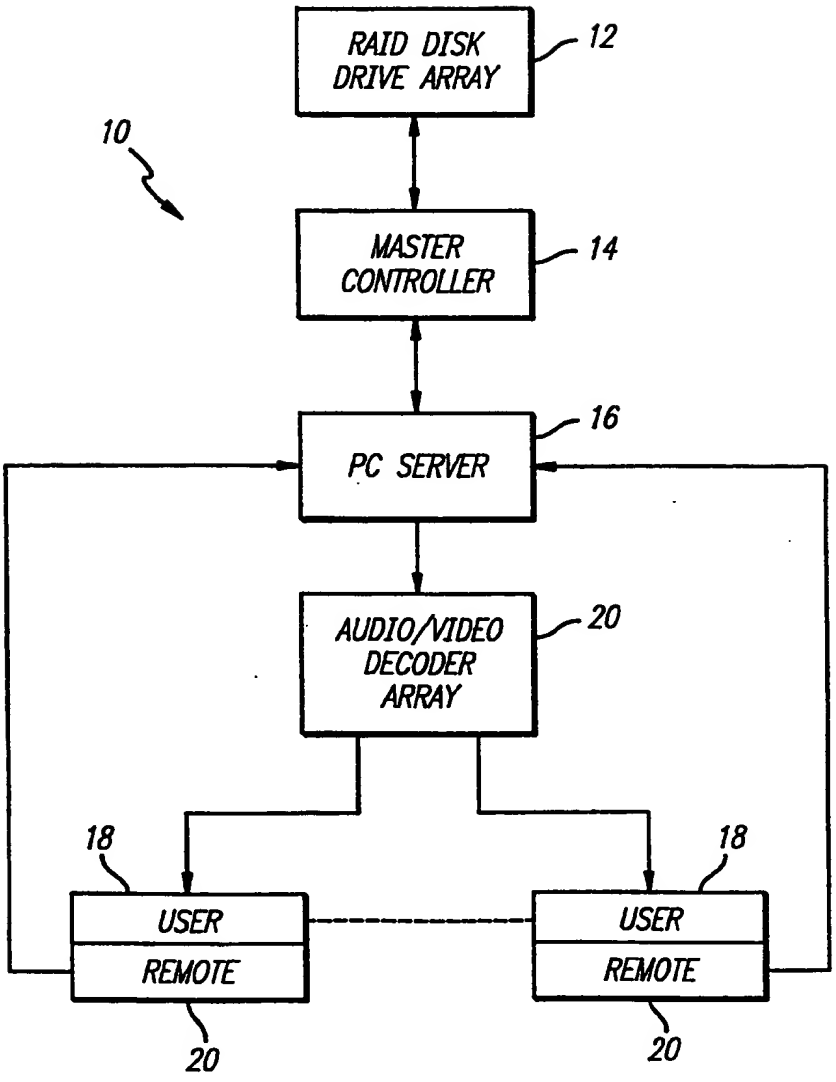


FIG. 2

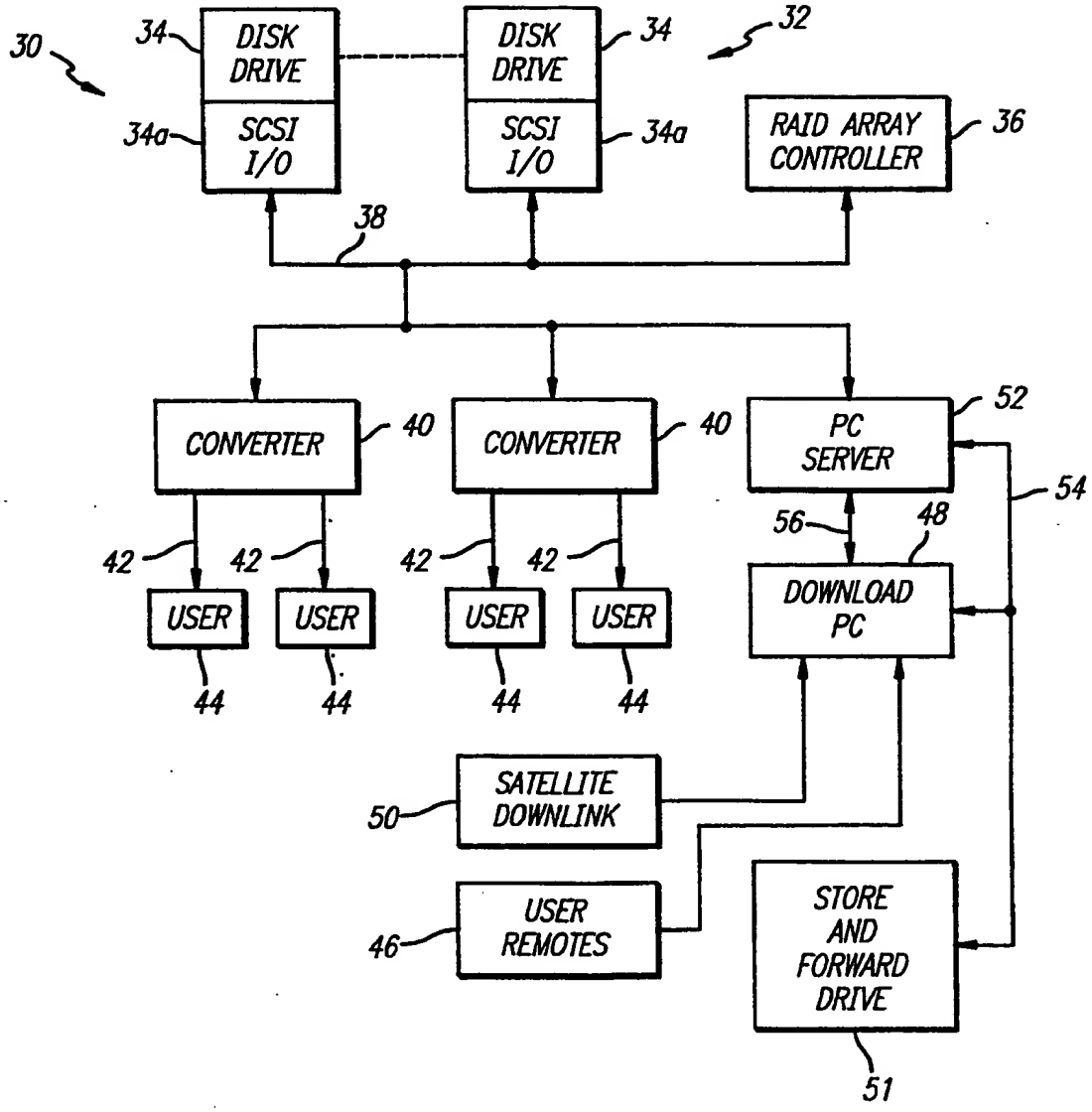

30
34
DISK DRIVE
34a
SCSI I/O
DISK DRIVE
34
SCSI I/O
34a
32
RAID ARRAY CONTROLLER
36
38
CONVERTER
40
CONVERTER
40
PC SERVER
52
54
56
48
DOWNLOAD PC
42
42
42
42
USER
USER
USER
USER
44
44
44
44
SATELLITE DOWNLINK
50
USER REMOTES
46
STORE AND FORWARD DRIVE
51

FIG. 3a

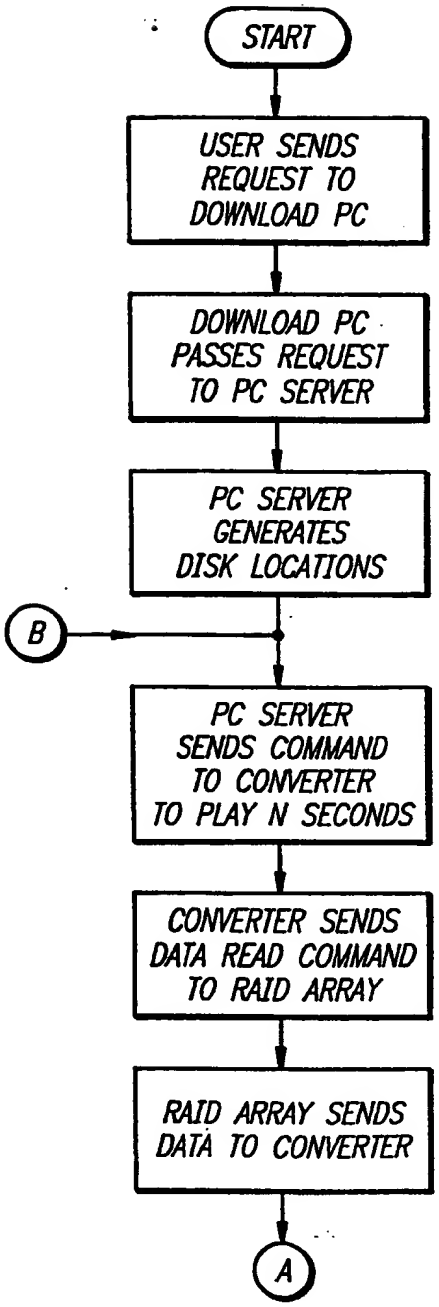

START
USER SENDS REQUEST TO DOWNLOAD PC
DOWNLOAD PC PASSES REQUEST TO PC SERVER
PC SERVER GENERATES DISK LOCATIONS
B
PC SERVER SENDS COMMAND TO CONVERTER TO PLAY N SECONDS
CONVERTER SENDS DATA READ COMMAND TO RAID ARRAY
RAID ARRAY SENDS DATA TO CONVERTER
A

FIG. 3b

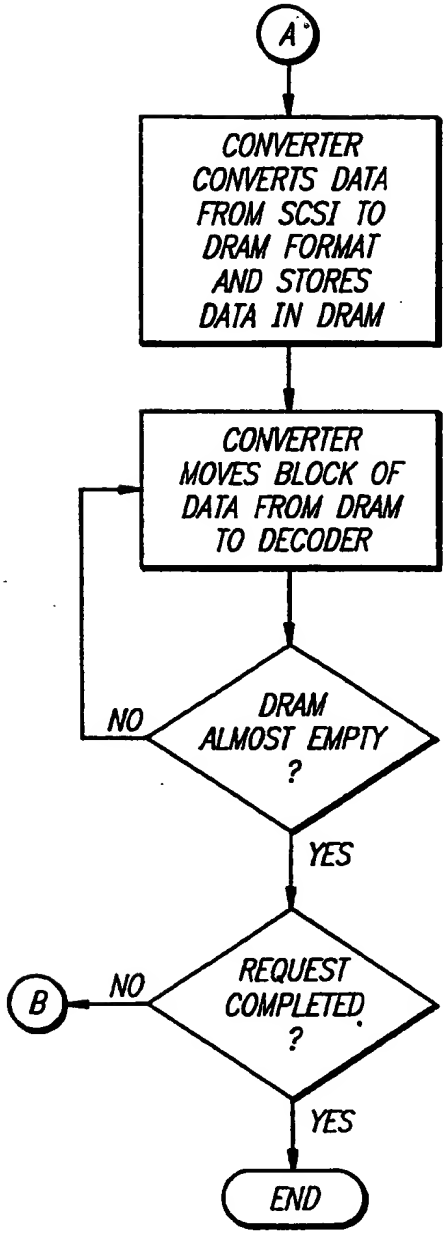

A
CONVERTER CONVERTS DATA FROM SCSI TO DRAM FORMAT AND STORES DATA IN DRAM
CONVERTER MOVES BLOCK OF DATA FROM DRAM TO DECODER
DRAM ALMOST EMPTY ?
NO
YES
REQUEST COMPLETED ?
B
NO
YES
END

FIG. 4

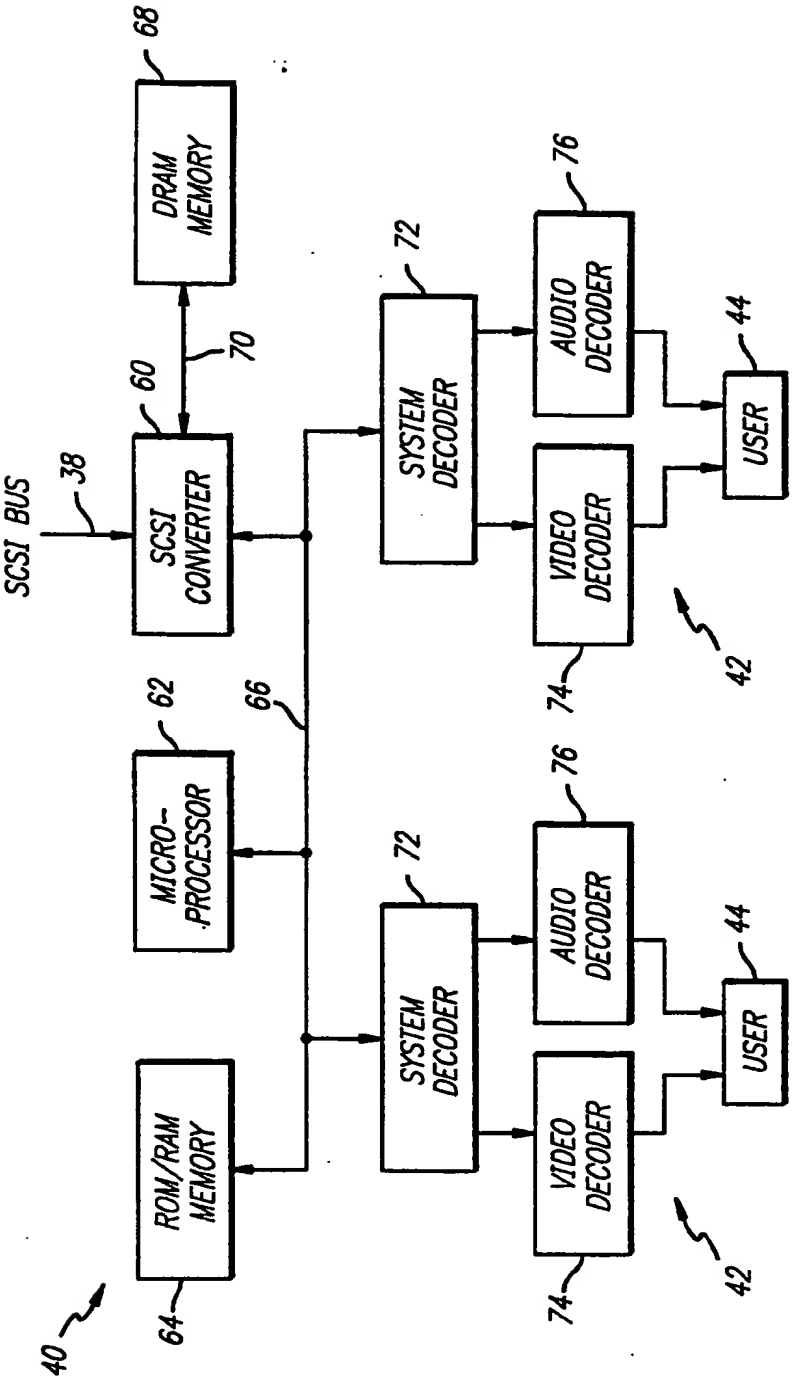
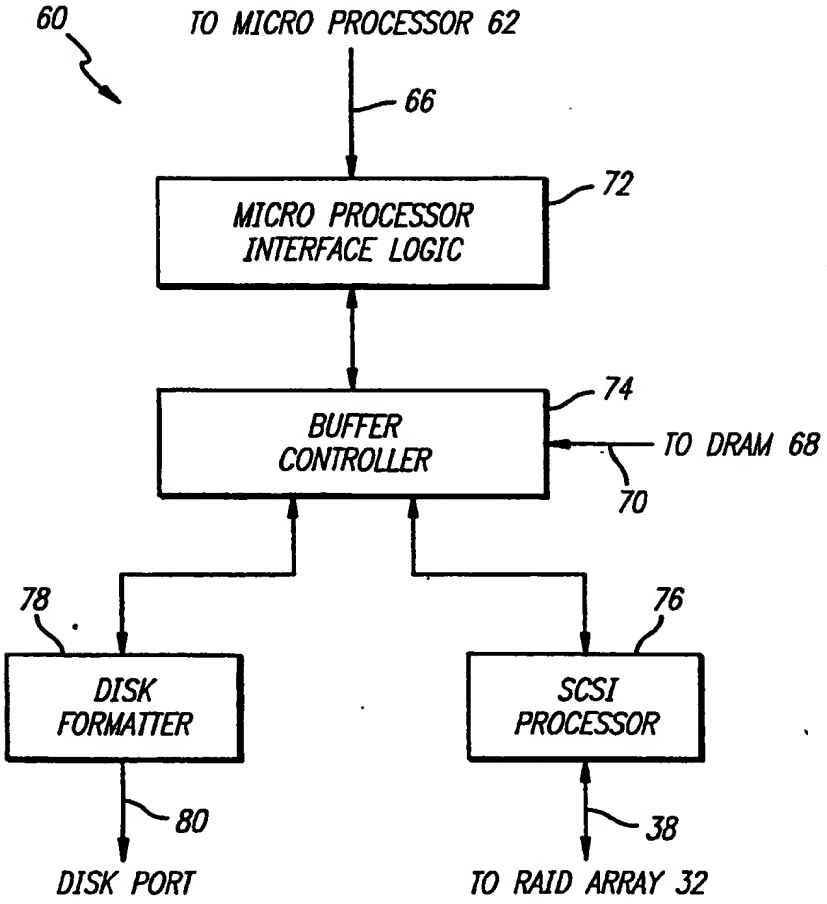

SCSI BUS
38
SCSI CONVERTER
60
DRAM MEMORY
68
70
MICRO-PROCESSOR
62
ROM/RAM MEMORY
64
66
40
SYSTEM DECODER
72
AUDIO DECODER
76
VIDEO DECODER
74
USER
44
42

FIG. 5


60
TO MICRO PROCESSOR 62
66
MICRO PROCESSOR INTERFACE LOGIC
72
BUFFER CONTROLLER
74
TO DRAM 68
70
78
76
DISK FORMATTER
SCSI PROCESSOR
80
38
DISK PORT
TO RAID ARRAY 32

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/03435

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 5/76
US CL :358/335
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 5,274,463 (MATSUMOTO ET AL.) 28 December 1993, Fig. 1 and its respective disclosure.	1-7 and 11-17 --- 8-10 and 18-20
X --- Y	US, A, 5,191,436 (YONEMITSU) 02 March 1993, Fig. 10 and its respective disclosure.	21-23 --- 8-10 and 18-20
A	US, A, 5,231,512 (EBIHARA ET AL.) 27 July 1993, Fig. 1.	1-23
A	US, A, 4,920,432 (EGGERS ET AL.) 24 April 1990, Fig. 1.	1-23

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search 12 MAY 1995	Date of mailing of the international search report 26 JUN 1995
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer THAI TRAN Telephone No. (703) 305-4725

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/03435

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

U.S.: 358/335, 310, 311, 342; 348/7, 8, 12, 552; 360/13, 14.1, 14.2, 14.3, 69, 72.1; 455/4.2.
IPC: H04N 5/76, 5/78, 5/781, 5/92, 9/79, 1/00, 7/10.